SmartRay

SmartRay™ ECCO 75 Series

User Manual

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Impressum

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Original User Manual

This English version represents the **Original User Manual**. All other language versions are translations of this **Original User Manual**.

Document History

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1 About this manual

1.1 General

Target group

This user manual is intended to help system integrators working in the field of 3D machine vision in the setup, installation and operation of SmartRay ECCO 75 3D sensors. The information in this user manual enables users or employees with the relevant experience to mount and operate the sensor.

Important note

The safe mounting, installation and commissioning of the sensor assumes knowledge of this user manual. It is essential, therefore, to read through this user manual – and the safety and warning instructions in particular – before beginning work.

1.2 Symbols and signal words

Safety instructions / Warnings

Safety instructions as used in this user manual:

WARNING

Source and description of danger

Possible consequences

- Measures of avoidance

WARNING

Indicates a possible laser radiation hazard. Non-observance of the safety instructions can result in severe injury, especially to eyesight.

Meaning of signal words

Meaning of signal words as used in this user manual:

Safety symbol	Signal word	Meaning
	DANGER	This signal word is used to indicate an **imminently dangerous situation** that will result in serious or fatal injury **if not avoided**.
	WARNING	This signal word is used to indicate a **potentially dangerous situation** that could result in serious or fatal injury **if not avoided**.
	CAUTION	This signal word is used to indicate a potentially dangerous situation that could result in minor or moderate injury if not avoided.
	ATTENTION	This signal word **without a warning symbol** is used to indicate potential danger of damage to property.
	NOTICE	This signal word indicates additional useful information for the reader, such as operating tips or cross-references.

Meaning of notice symbols

Following notice symbols are used to indicate useful information or cross-references:

	Important information that must be observed to avoid problems with the sensor.
	Further information that simplifies your work with the SmartRay sensor is marked with this symbol.
	Cross-references to other documents are marked with this symbol.

1.3 Abbreviations

Abbreviation	Description
2D/3D	2-dimensional/3-dimensional
API	Application Programming Interface
BG	German employer's liability insurance association
BGR	German employer's liability insurance association rules
CW	Continuous Wave
DIN	German Industrial Standards
EMC	Electromagnetic Compatibility
EN	European Norm
ER	Extended Range, outside Measurement Range (can be used for inspection applications, but it is not suitable for measurement applications)
ESD	Electrostatic Discharge
FOV	Field of View
GND	Ground
IEC	International Electrotechnical Commission
IO	Input/Output
ISO	International Organization for Standardization
LED	Light Emitting Diode
MR	Measurement Range
PIL	3D-Profile, Intensity, LaserLineThickness
RMA	Return Material Authorization
SDK	Software Development Kit
SO	Stand-off Distance, distance between the sensor front glass and the object
SR	SmartRay
VDE	German Association for Electrical, Electronic & Information Technologies
ZIL	Z-Map, $Intensity_{Z\text{-}Map}$, $LaserLineThickness_{Z\text{-}Map}$

2 Safety

2.1 Intended use

Fields of application

The SmartRay ECCO 75 3D sensor is designed for use in the industrial image processing sector.

It can be used for:

- Quality inspection
- Metrology
- Robot guidance
- Reverse engineering

The SmartRay ECCO 75 3D sensor may only be operated within the values specified in the technical data. See *Technical Data, page 18*.

Non-intended use

Any other use or use beyond that intended is deemed to be non-intended use. In the event of modification or reconstructions, operational safety is no longer ensured.

Safe operation

For the correct, safe and professional use of the SmartRay ECCO 75 3D sensor, it is essential to be familiar with and to heed the respective corresponding safety regulations and information.

NOTICE

Before commissioning your SmartRay sensor, carefully read through the laser safety warnings mentioned in the *ECCO Quick Guide booklet*.

2.2 Device-specific safety instructions

Proper handling of the sensor

WARNING

Danger of injury from improper handling of the sensor.

Non-compliance with these instructions can cause injury.

- Only work on the plant when you have been commissioned to do so and when you have been instructed on dealing with the plant and its functions.
- Read the corresponding chapters in the technical manual before carrying out work on the plant.
- Only operate the plant when all safety devices are present as they are essential for safe operation of the system.
- Only operate the plant in a flawless, properly functioning state.
- Ensure that the plant is regularly checked for proper functioning.
- Maintenance work and troubleshooting must be carried out by trained, authorized qualified personnel.
- Unauthorized constructional modifications to the plant can have an adverse effect on safety.
- Keep away from moving parts of the plant.

2.3 Warning against laser beams

2.3.1 Safety review

Laser class of your sensor

WARNING

Danger of injury from laser radiation.

The laser of this sensor complies with **laser class 2M**.

Laser power 15 mW

Wavelength of 660 nm

Looking directly into the beam for a time period of more than 0.25 s or repeatedly looking into the laser beam of class 2M laser products can lead to eye injuries.

- Do not look directly into the laser beam!
- Observe the general laser safety regulations (see information on laser safety warnings mentioned in the *ECCO Quick Guide booklet*)!

Obligations of the operating company

For safety reasons, the operating company of the 3D laser system has important duties to ensure safety during operation. In particular, the following applies:

- Cordoning-off of the laser area.
- Clear marking of the laser area.
- Operation of the laser with the minimum required power.
- Carrying out of work on the laser measurement system only by specially trained personnel.
- Checking of the laser protection safety measures by a laser safety officer.

NOTICE

In addition to the information given on the topic of laser safety in this user manual, also heed the separate information in the *SmartRay – General laser safety* and the Laser safety chapter.

2.3.2 Laser safety

Laser safety

The tight bundling of the laser beam means the entire energy of the radiation is concentrated on a small cross-section. If a person is hit by the beam, this can cause damage to health. Depending on the wavelength of the laser, the beam can reach the retina and damage it.

According to the potential hazard, lasers or devices that contain a laser are divided into classes in accordance with EN 60 825 "Safety of laser products".

The SmartRay ECCO 75 **3D sensor belongs to class** 2M**.**

Due to the tight bundling and the associated high power density of the laser beams, the beams in more powerful laser products can be damaging to health. This also applies to reflections on

- glass surfaces
- metallic surfaces
- polished surfaces.

NOTICE

- The laser class of the sensor can be found on the label of the sensor.
- The laser classes listed in the following comply with the standard DIN EN 60825-1 (VDE 0837-1):2008-05 - October 2007 release.

2.3.3 Laser classes

Laser class 2M

The available laser radiation of laser products of class 2M lies in the visible spectral range (400 nm to 700 nm).

In laser products of class 2M, there is a comparable hazard to laser products of class 2 provided no optical instruments (e.g. magnifying glass or microscope) are used that reduce the beam cross-section.

WARNING

Danger of injury from laser beams.

Looking directly into the beam for a time period of more than 0.25 s or repeatedly looking into the laser beam of class 2M laser products can lead to eye injuries.

- If laser radiation of class 2M hits the eyes, consciously close your eyes and immediately turn away.

Laser class 3B

The available laser radiation lies in the wavelength range of 302.5 nm to 10^6 nm and is dangerous to the eyes, frequently also to the skin.

WARNING

Danger of injury from laser beams.

Looking directly into the beam in laser products of class 3B is dangerous!

- Observe the laser safety regulations.
- When working on the sensor, wear the laser protection glasses provided for this purpose.

2.3.4 Laser-specific regulations

Labeling of the laser classes (laser warning labels)

According to section 5.8 DIN EN 60825-1, laser products of classes 2 to 4 must be identified on a label by data about the maximum initial values of the laser radiation, the emitted wavelength and (if applicable) the pulse duration.

Example of the labeling of a laser:

Laser class 2M	Laser class 3B

Measures for laser class 3B

According to DIN EN 60825-1, a system with a laser of class 3B must fulfill the following:

- All directives of the preceding laser classes (technical expertise, labeling, access restrictions among other things) apply
- Nomination of a laser safety officer
- An installed signal lamp must indicate the operating status of the laser
- Remote-controlled locking system
- Key switch
- Beam attenuator
- Eye protection (if constructive and organizational measures are not practicable)

WARNING

Danger of injury from reflecting laser beams.

To avoid harm to personnel, comply with the following instructions:

- Do not use reflective tools during adjustment work.
- Do not wear any reflective objects (e.g. jewelry).
- Where applicable, national directives and measures that are not listed here must be fulfilled.

2.4 ESD protection

Manufacture and checking by SmartRay

The sensors are manufactured and checked at SmartRay premises under stringent ESD protective measures (according to IEC 61340-5-1). These protective measures are already demanded from and complied with by our suppliers. The sensors are sent in ESD-conform packaging. This protects the contents from electrostatic charges.

Recommendations for handling the sensor

ATTENTION

Risk of destroying the sensor.

Because the sensor is a sensitive electronic part, it can be destroyed by improper handling.

- Only carry out assembly in accordance with the applicable ESD protective measures.

Recommendation for ESD handling:

- Ground the service personnel and work area during assembly and/or repair work.
- Avoid contact with the connector contacts.

ATTENTION

Risk of destroying the sensor.

Because the sensor is a sensitive electronic part, it can be destroyed by improper handling.

- Keep the original packaging and use it in case sending the sensor back for repair will be necessary (ESD protection).

3 Sensor at a glance

3.1 Overview

Introduction

This section describes

- How the sensor is constructed
- Typical fields of application
- The working principle

System components

A functioning sensor system consists of the following components:

- SmartRay ECCO 75 3D sensor
- Power-I/O-Encoder cable
- Ethernet cable
- StarterKit Software with a "Getting Started" installation guide (PDF)
- USB stick with calibration file (Look-up table, *.lut)

Sensor series

The following type of model of the ECCO 75 series is available:

- ECCO 75 series
  - ECCO 75.100

3.2 Working principle

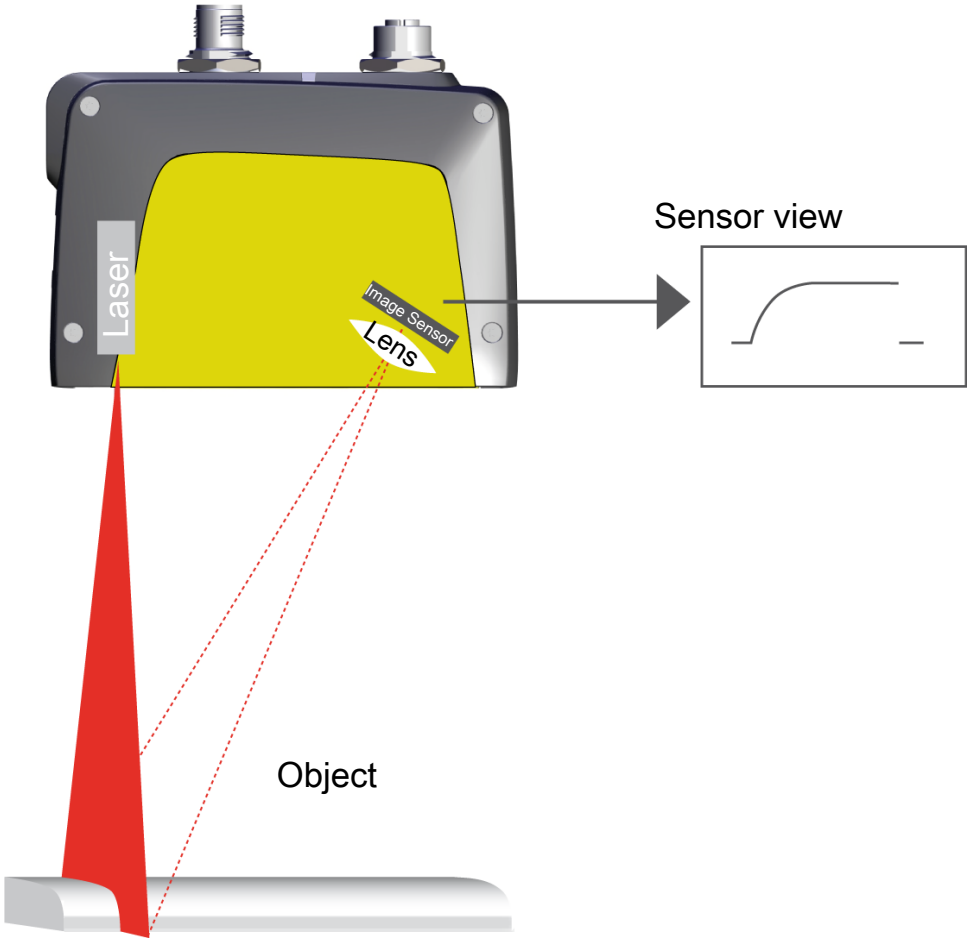
Function

SmartRay 3D sensors measure distances based on the laser triangulation principle.

The 3D sensor projects a laser line onto the object which is reflected back onto an image sensor. Due to the triangulation angle between the laser line, object and the image sensor, the reflected laser line appears at different positions on the image sensor depending on different distances to the measured object. In other words, the 3D sensor measures the profile of the object, and scanning the object renders a 3D-model of the object!

The calibration methods developed by SmartRay allow for measurements in the micrometer range!

Schematic diagram of laser triangulation

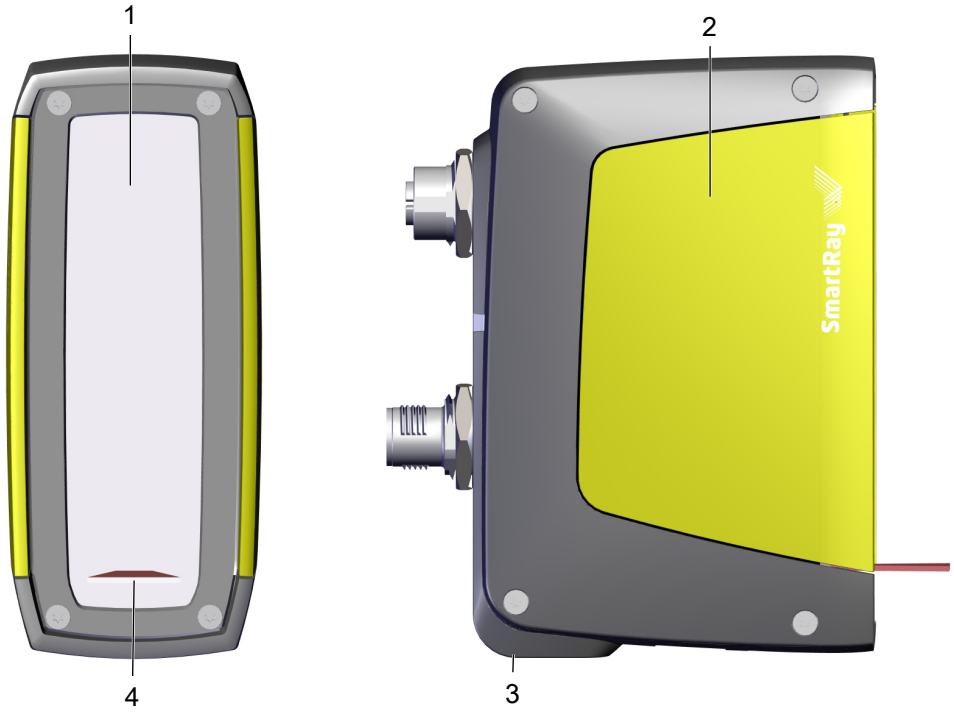


3.3 Description

3.3.1 Sensor views

Sensor view (front | side)

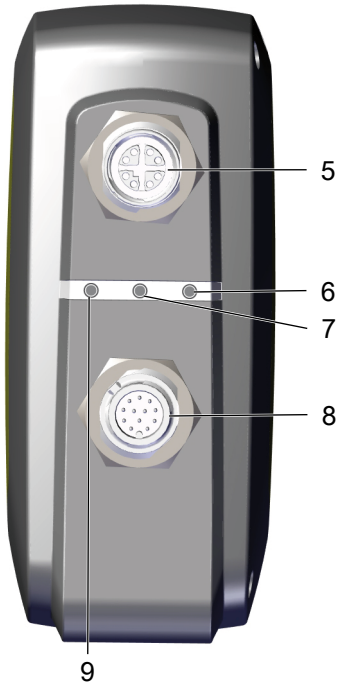
The following figures show the ECCO 75 3D sensor from the front and side:



1 Camera front glass
2 Housing
3 Threaded holes for mounting screws
4 Laser output

Sensor view (rear)

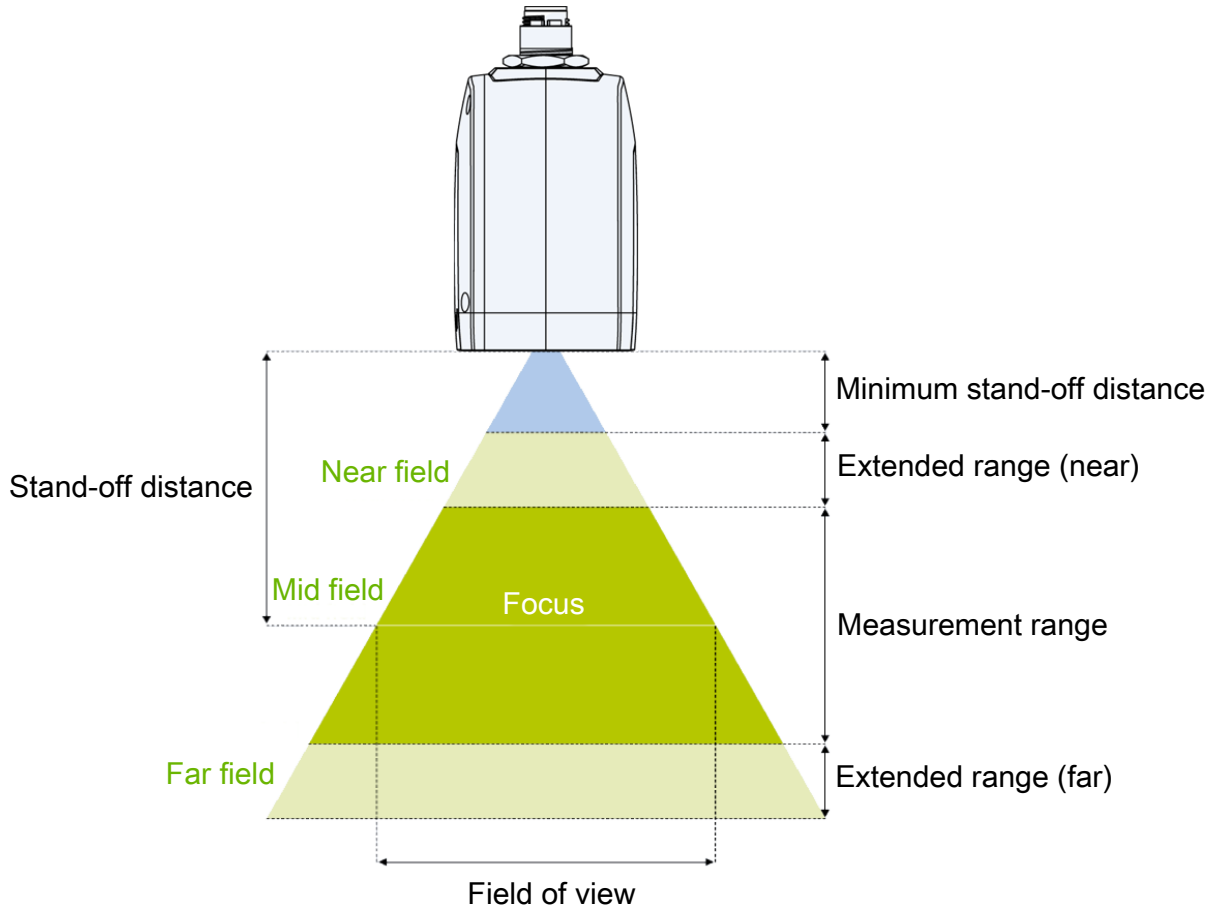
The following figure shows the sensor from the rear with its electrical connectors:



5 Ethernet connector (8-pin female)
6 Power LED
7 LED (reserved for future use)
8 Power-I/O-Encoder connector
9 Boot status LED | Connection LED

3.3.2 Technical data

Sensor specification



Technical data ECCO 75 series

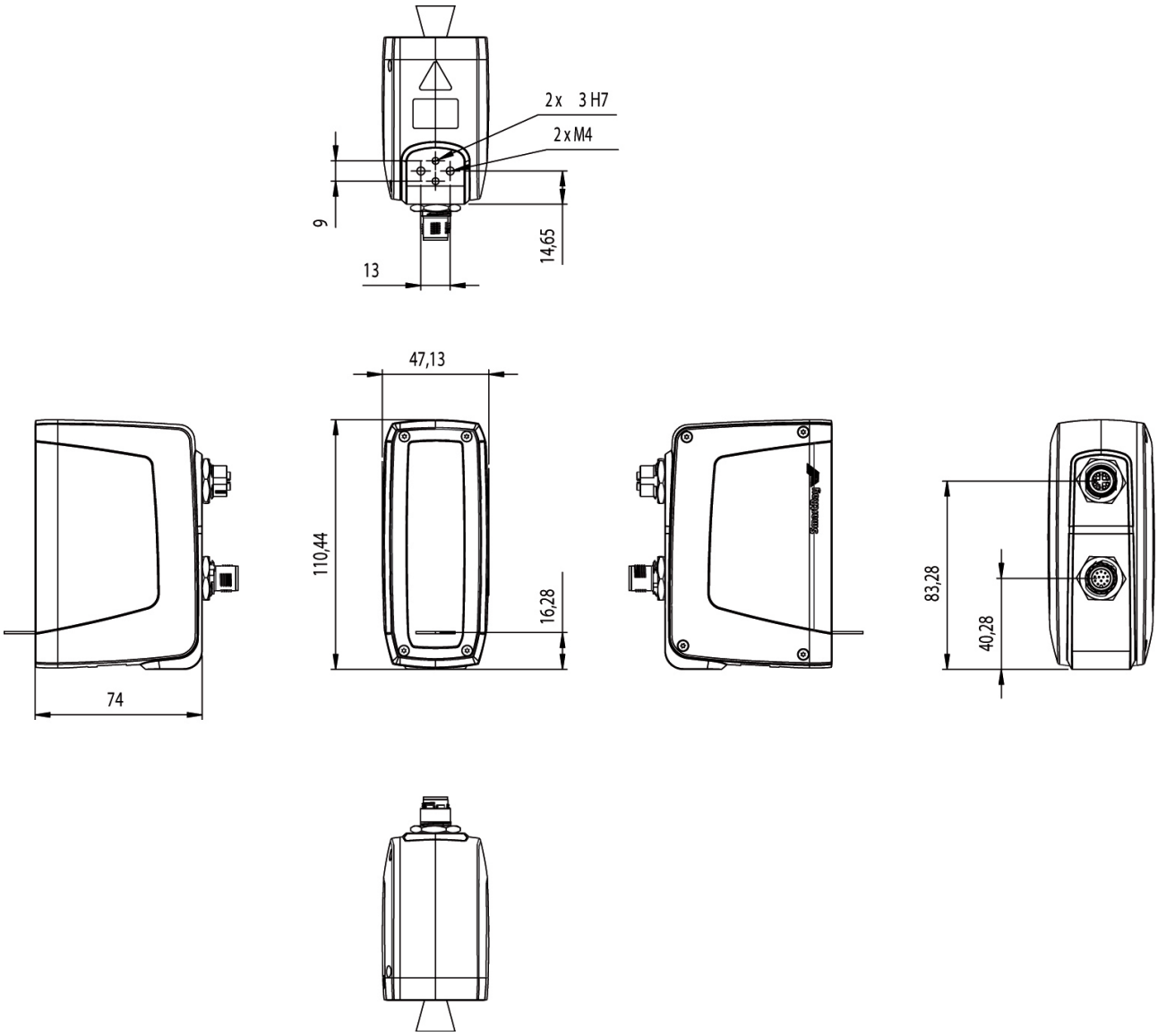
Model	ECCO 75.100
Field of view [mm] (near | **mid** | far)	72 | **98** | 124
Measurement range [mm]	100
Stand-off distance [mm]	150
Typical vertical resolution [µm]	5 – 12
Typical lateral resolution [µm]	42 – 70
Weight	Approx. 480 g
Part number	3.002.120
Maximum points / 3D-profile	1920

Model	ECCO 75.100
Typical scan rate (Scan rate is dependent on the configured field of view, measurement range and exposure time. The typical scan rate has been estimated with an time of 1 µsec)	Approx. from 150 Hz up to 4 KHz
Interface	Gigabit Ethernet (1 Gbit/sec)
Inputs	4 x Inputs, 5 – 24 VDC | Quadrature Encoder (AB-Channel, RS-422 standard)
Outputs	2 x Outputs, 24 VDC
Input voltage | Power	24 VDC, ± 15 % ripple | 7.5 W
Laser wavelength	660 nm
Laser class (standard | optional)	2M | –
Maximum ambient light	10,000 lx
EMC test	as per EN 61 000-6-2, EN 61 000-6-4
Vibration / Shock test	as per EN 60 068-2-6, -27, -29, -64
Electrical safety	as per EN 61 010-1-3
Protection class	III, as per EN 61 040-3
Enclosure rating	IP65
Air humidity	Maximum 90%, non-condensing
Temperature (operation | storage)	0 – 40° C | -20 – 70° C

Nameplate

Example: Nameplate of the ECCO 75 series

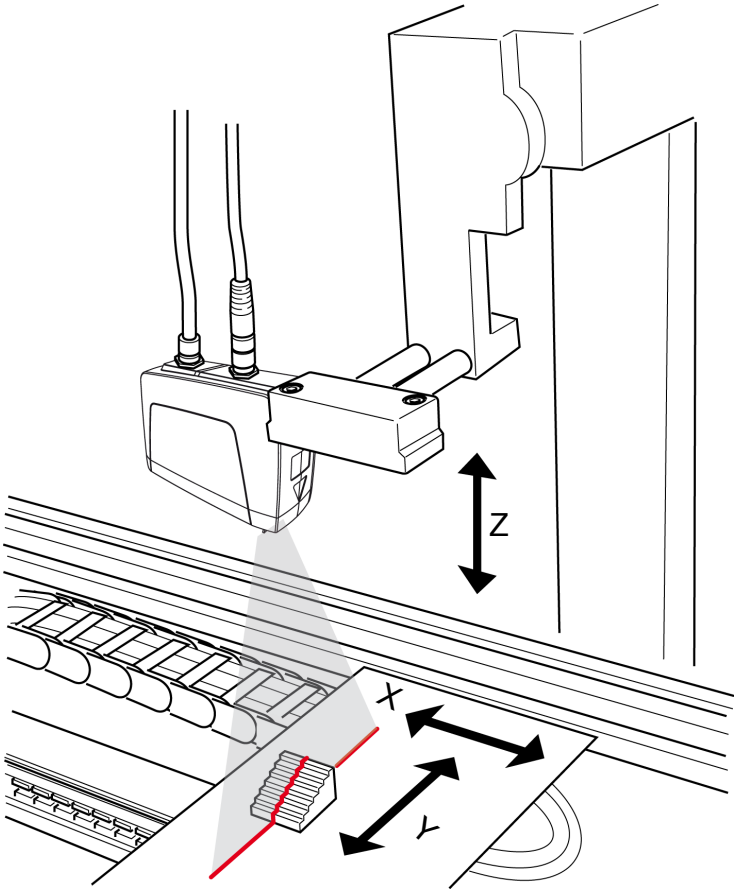
Dimensional drawing



3.4 Coordinate system

Definition of coordinates

The three axes in the coordinate system are defined as follows:



X Scan or transport direction
Y Along the laser line
Z Height or distance between the sensor and the object

3.5 Calibration

Sensor calibration

Highest accuracy of measurement is achievable thanks to a calibration procedure specially developed by SmartRay. Each sensor unit is individually calibrated with a variety of reference points within the field of view and measurement range. As a result, any kind of distortion and deviation is corrected, some of which are:

- Perspective distortion
- Lens distortion
- Laser non-linearity
- Manufacturing tolerances

Sensor-specific calibration data

The result of calibration is saved onto a "calibration file" which is shipped along with each sensor on a USB stick. The calibration file is basically a look-up table, often simply referred to as LUT and has a file extension '*.lut'.

The data from the sensor along with the combination with the calibration file gives the advantage of generating your data in real world coordinate dimensions, i.e. in millimeters.

NOTICE

In case you misplaced your USB stick, i.e. lost your calibration file, please get in touch with your SmartRay contact person along with the “serial number” of the sensor via support@smartray.de .

3.6 Part numbers

ECCO 75 series

Model	Part number
ECCO 75.100	3.002.120

Accessories

Power-I/O-Encoder cable	Part number
Power-I/O-Encoder cable (Standard, 5 m)	6.320.005
Power-I/O-Encoder cable (Standard, 10 m)	6.320.010

Ethernet cable	Part number
Ethernet cable (Standard, 5 m)	6.303.005
Ethernet cable (Standard, 10 m)	6.303.010

NOTICE

In regard to the subsequent use of accessories, please get in touch with your contact person at SmartRay.

4 Installation

4.1 Mounting the sensor

Preparation

Prepare an appropriate holder (e.g. on the robot, assembly line).

For hole pattern dimensions, see section Description.

Procedure

Proceed as follows in order to mount the sensor on the holder provided:

Step	Action
1	Unpack the sensor and cables.

ATTENTION

Risk of destroying the sensor.

Because the sensor is a sensitive electronic part, it can be destroyed by improper handling.

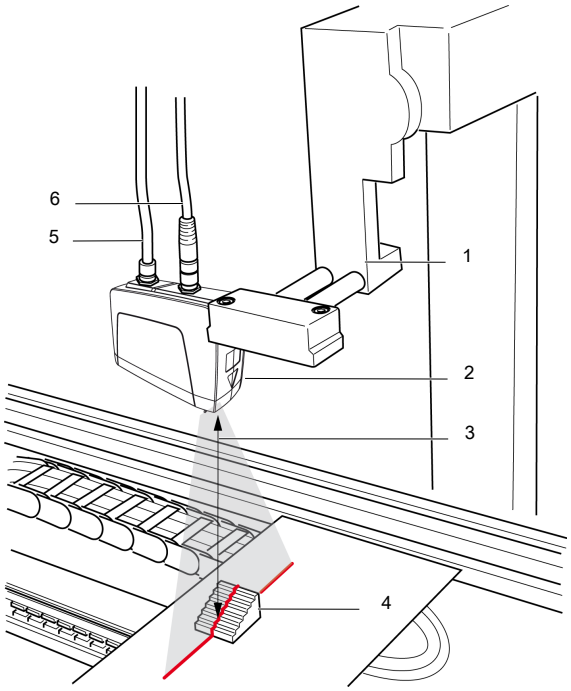
- Keep the original packaging and use it in case sending the sensor back for repair will be necessary (ESD protection).

Step	Action
2	Fix the sensor in place on the holder (fixing holes). Tightening torque: 4 Nm.

NOTICE

The sensor must be mounted to the object at a certain distance. This "Stand-off distance (mid)" is measured from the front of the sensor to the area of interest on the object and can be looked up in the technical data of the sensor under "Stand-off Distance".

Sensor orientation

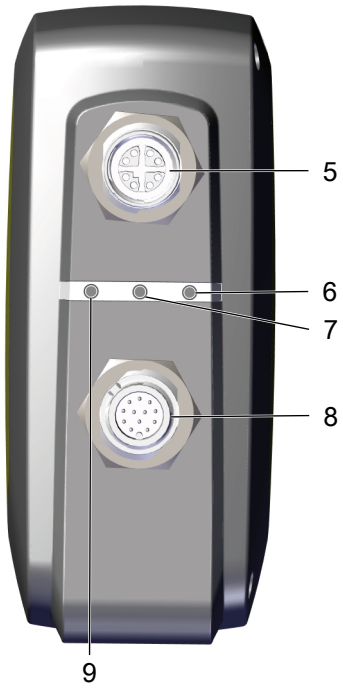


1 Stand / Holder
2 3D sensor
3 Stand-off distance (mid)
4 Object
5 Ethernet cable
6 Power-I/O-Encoder cable

4.2 Connecting cables

Connections and displays

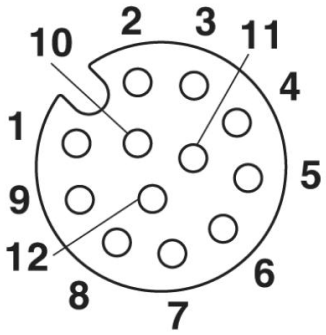
The following figure shows the sensor from the rear with its electrical connections and displays:



5 Ethernet connector (8-pin female)
6 Power LED
7 LED (reserved for future use)
8 Power-I/O-Encoder connector
9 Boot status LED | Connection LED

Terminal assignment M12 connector

Power-I/O-Encoder cable Pinout Description



Description of cable wiring

Pin	Wire color	Brief designation	Meaning/Description
Pin 1	Brown – Blue	Ground	Operating voltage -, 0 V
Pin 2	Brown – Red	VCC	Operating voltage +, 24 VDC ± 15% ripple
Pin 3	Grey	Input 1	5 – 24 V
Pin 4	Red	Output 2	24 V (max. 20 mA)
Pin 5	Orange	Output 1	24 V (max. 20 mA)
Pin 6	Brown	Encoder B-	RS-422 complaint
Pin 7	Green	Encoder A+	RS-422 complaint
Pin 8	Blue	Input 3	5 – 24 V
Pin 9	White – Yellow	Input 4	5 – 24 V
Pin 10	White – Black	Input 2	5 – 24 V
Pin 11	Black	Encoder B+	RS-422 complaint
Pin 12	Yellow	Encoder A-	RS-422 complaint
	Yellow – Green	EARTH	Grounding Shield

ATTENTION

Risk of destroying the sensor.

In order to avoid damage to the sensor, follow these instructions:

- Before sensor power-up, ensure that the corresponding pin of an **unused sensor input** is terminated (mechanically fixed).
- Make sure, the pin is connected to Ground.
- The input signal voltage must not exceed the operating voltage (VCC).

ATTENTION

Risk of destroying the sensor.

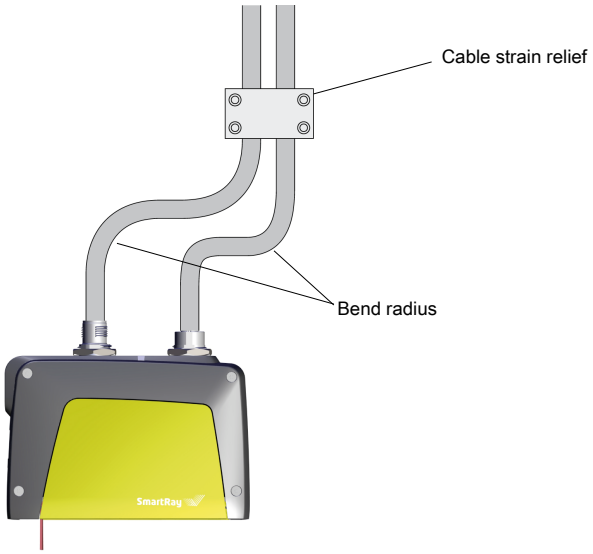
In order to avoid damage to the sensor, follow these instructions:

- Before sensor power-up, ensure that the corresponding pin of an **unused sensor output** is mechanically fixed in an insulated screw joint.
- Ensure that the pin is **not** connected to Ground.

Bending radius/Strain relief device of the cables

Schematic representation

The following image shows the strain relief device and bending radius of the cables:



	ATTENTION **Risk of damage to the cables.** Going below the minimum bending radius results in damage to the cables and can lead to faulty transfer of signals and data. Any damage leads to mandatory replacement of the cables. ● Adhere to the minimum admissible bending radius.

Bending radius

The typical bending radius to be used is shown in the following table:

Minimum bending radius (d = diameter)

Installation type	Formula	Minimum bending radius for SmartRay cables (d = 7.8 mm)
Fixed	5 x d	39.5 mm
Freely moving	10 x d	79.0 mm
Constantly moving	12 x d	94.8 mm

Strain relief device

If the cables are constantly in motion (operating on the robot/axis), it is important to ensure that a strain relief device is mounted, which does not allow transverse and tractive forces on the connector and socket of the sensor.

ATTENTION

Risk of damage to the cables.

If the cables are constantly in motion (operation on the robot/axis), they can be damaged.

- Install a strain relief. Make sure that the strain relief does not permit transverse and tensile forces on the plug connector and socket of the sensor.
- In case of damage, cables have to be replaced.

4.3 StarterKit Software

StarterKit Software

The StarterKit Software is part of the sensor delivery. The software has to be installed on the host computer to be able to configure and communicate with the sensor.

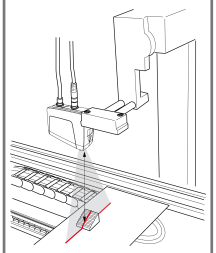
NOTICE

For installation of the StarterKit Software see SmartRay document *Getting Started*. This installation guide is part of the sensor delivery (PDF).

4.4 Step-by-step installation

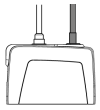
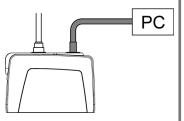
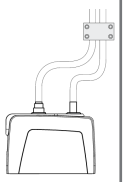
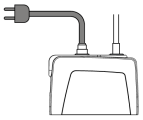
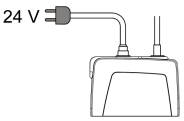
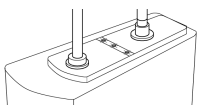
Connecting the sensor and establishing readiness for operation

Proceed as follows in order to connect the sensor and to establish readiness for operation:

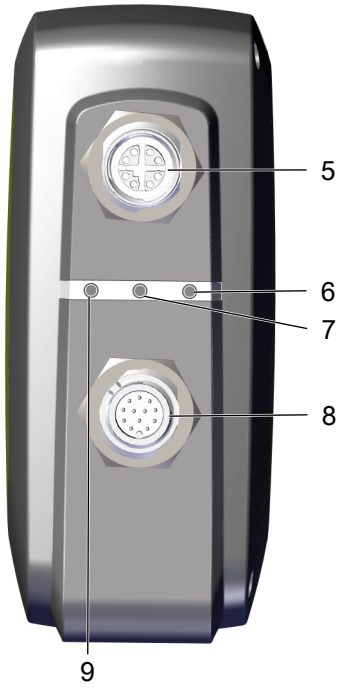
Step	Action	Schematic
1	Check that the sensor maintains the correct "stand-off distance" between sensor and object, according to the technical specifications of the sensor model.	
2	Connect the Power-I/O-Encoder cable to the socket on the mounted sensor. **NOTE** Do not power on the sensor.	

	ATTENTION **Risk of destroying the sensor.** In order to avoid damage to the sensor, follow these instructions: • Before sensor power-up, ensure that the corresponding pin of an **unused sensor input** is terminated (mechanically fixed). • Make sure, the pin is connected to Ground. • The input signal voltage must not exceed the operating voltage (VCC).

	ATTENTION **Risk of destroying the sensor.** In order to avoid damage to the sensor, follow these instructions: • Before sensor power-up, ensure that the corresponding pin of an **unused sensor output** is mechanically fixed in an insulated screw joint. • Ensure that the pin is **not** connected to Ground.

Step	Action	Schematic
3	Connect the Ethernet cable to the socket on the mounted sensor.	
4	Connect the Ethernet cable to the host computer.	
5	If necessary, attach a strain relief device. When laying the cables, pay attention to compliance with the minimum bending radius.	
6	Connect the Power-I/O-Encoder cable to a 24 V power supply.	
7	Apply the supply voltage.	
8	Check readiness for operation. **NOTE** The Power LED indicates whether the sensor is supplied with supply voltage. The Boot status LED / Connection LED indicates if the sensor is ready for operation.	

Step	Action	Schematic
9	Install the StarterKit Software to start capturing data from the sensor. **NOTE** See installation guide *Getting Started*.	



5 Ethernet connector (8-pin female)
6 Power LED
7 LED (reserved for future use)
8 Power-I/O-Encoder connector
9 Boot status LED | Connection LED

Power LED

The Power LED indicates the following operating states of the sensor:

Power LED	Meaning
BLUE	Sensor is provided with a supply voltage of 24 V

Boot status LED | Connection LED

The Boot / Connection LED indicates the following operating states of the sensor:

Boot status LED | Connection LED	Meaning
WHITE (blinking at slow frequency)	Booting state on power-up

Boot status LED | Connection LED	Meaning
WHITE (blinking at higher frequency)	Boot state (during firmware update)
ORANGE (blinking)	Boot complete, “Waiting for connection” state
GREEN (glowing)	Connection between host computer and sensor has been established
RED (glowing)	Error state

Additional LED

The third LED, located in the middle, is reserved for future use.

5 Get started

5.1 Connection Setup

General

After you have mounted and powered your ECCO 75 3D sensor successfully, it's time to establish a connection between the sensor and the host computer. Prior to this, please make sure that you have installed the latest version of the "StarterKit Software" on the host computer.

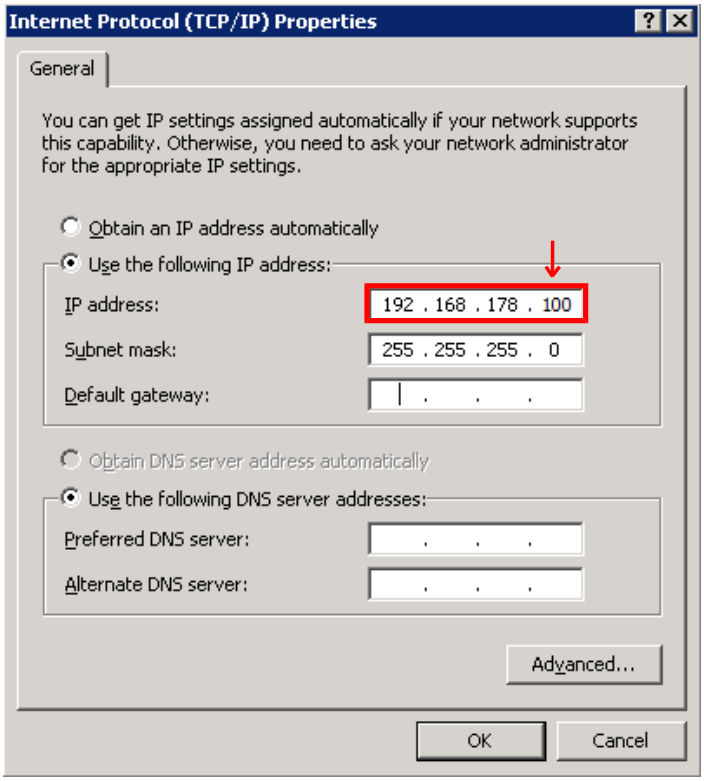
You can connect to the sensor using SmartRay Studio 4 or 3rd party application softwares supported by SmartRay.

NOTICE

Make sure to configure the IP address of your computer network card to lie in the same range of the sensor's IP address.

IP address of the host computer

The last three numbers may not be the sensor IP-address (e.g. 200) or 0 (see arrow).


Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
192 . 168 . 178 . 100
Subnet mask:
255 . 255 . 255 . 0
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Advanced...
OK
Cancel

Factory default ‘IP address | Port number’

The sensors shipped by SmartRay are configured with the following standard IP address and port number:

- Default IP address: 192.168.178.200
- Port number: 40

Use the available connection manager to configure the IP address of the sensor.

5.2 Capturing Data

General

After proper installation and connection, the sensor is ready for operation.

Information on the data (images, point clouds) provided by the sensor can be found in the following section.

Function

The 3D sensor generates 3D data of an object line by line, and therefore a relative movement between the sensor and/or the object is necessary to create the complete 3D model of the scanned object.

Data from SmartRay 3D sensors can be grouped into 2 parts:

Non-Calibrated Data

- Live Image (Setup & Debug)
- 3D Profile
- Intensity
- Laser Line Thickness

Calibrated Data

- Point Cloud
- Z-map
- $\text{Intensity}_{\text{Z-Map}}$
- $\text{Laser Line Thickness}_{\text{Z-Map}}$

Coordinate types

SmartRay technology distinguishes between two different kinds of coordinate systems:

- Image coordinate
  non-calibrated coordinates in pixels
- World coordinate
  calibrated coordinates in millimeters

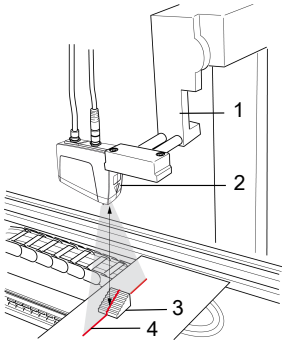
NOTICE

For more detailed information regarding the structure of the image data, please refer to the *SmartRay* API user manual.

5.3 Image types

5.3.1 Live Image

The Live Image enables to start the capture of a live video stream from the sensor with the configured sensor parameters (ROI / Exposure / Gain, etc.).

Designation	Description	
General	The Live Image represents a normal video stream (i.e. 2D-images type in pixel). The Live Image is very helpful in setting up the sensor parameters and debugging to assist in capturing your 3D-data. **Note** Using the possibilities of your application software, you should setup the Live Image following these tips: • not under-exposed, • not over-exposed, • optimum exposure: the laser line reflected from the object is thin and sharp.	
Format/Bit depth	Image / 8, i.e. 8 bits/pixel (range 0 – 255)	
Live Image example	**Sensor setup**  1 Stand 2 ECCO 75 3D sensor 3 Object 4 Laser line	**Live Image**

5.3.2 Non-Calibrated 3D image data types

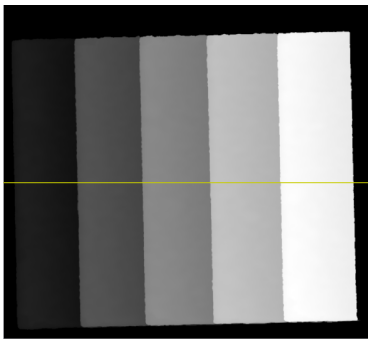
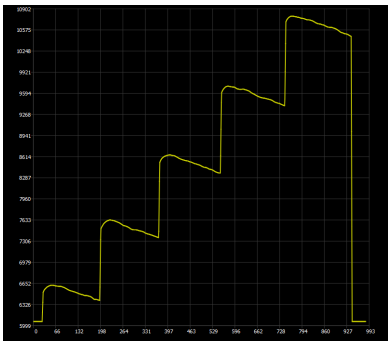
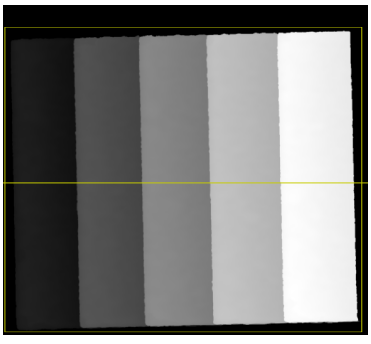
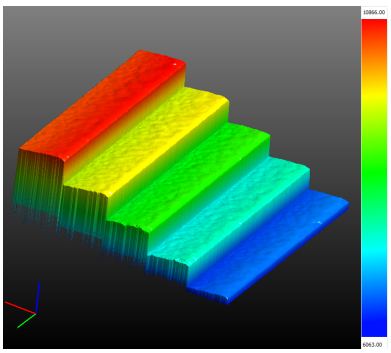
Overview

The sensor offers the following Non-Calibrated 3D image formats (in pixel e.g. in image coordinate system):

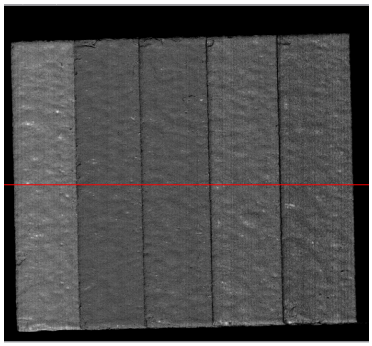
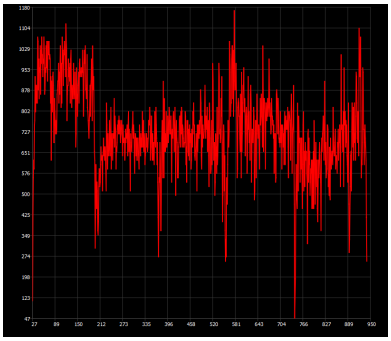
- 3D Profile
- Intensity
- Laser Line Thickness

These image formats are abbreviated as PIL (**P**rofile, **I**ntensity, **L**aserLineThickness).

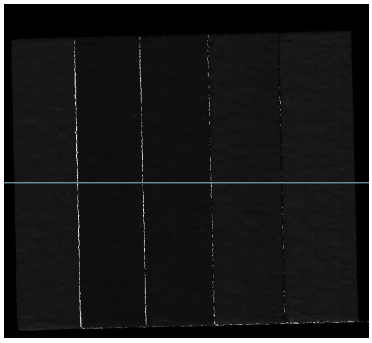
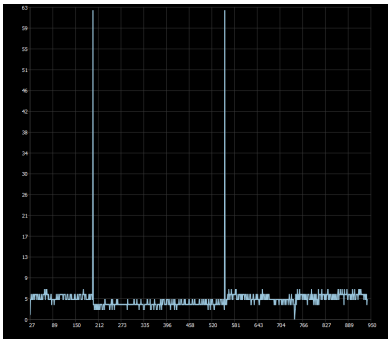
3D Profile

Designation	Description	
General	The non-calibrated 3D Profile image is an image, which represents for each pixel the height (Z-dimension) of the scanned object.	
Data format	16 bit image (Ex: PNG format)	
3D Profile example: Bit depth: 16 bits/pixel (range 0 – 65,535)	**3D Profile Map** 	**Graphic analysis** 
	3D Profile Map 	**3D Visualization** 

Intensity

Designation	Description	
General	The non-calibrated Intensity image is an image, which represents for each pixel the intensity of the reflected light from the scanned object.	
Data format	16 bit image (Ex: PNG format)	
Intensity example: Bit depth: 16 bits/pixel (range 0 – 65,535)	**Intensity Map** 	**Graphical analysis** 

Laser Line Thickness

Designation	Description	
General	The non-calibrated Laser Line Thickness image is an image, which represents for each pixel the thickness of a laser line of the scanned object.	
Data format	6 bit image (Ex: PNG format)	
Laser Line Thickness example: Bit depth: 6 bits/pixel (Range: 0 - 63)	**Laser Line Tickness Map** 	**Graphical analysis** 

5.3.3 Calibrated 3D image data types

Overview

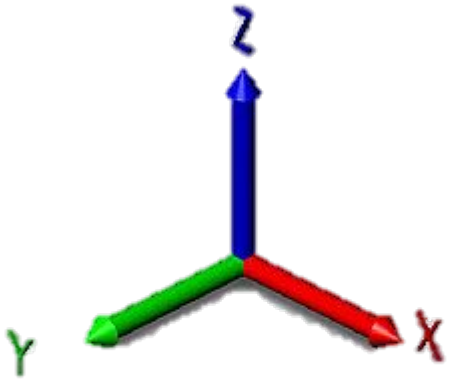
With the help of a calibration file, i.e. a look up table (LUT), that is unique for each and every sensor, the non-calibrated pixel coordinates (X_{Image}, Y_{Image}) are converted to calibrated coordinates (X_{World}, Y_{World}, Z_{World}).

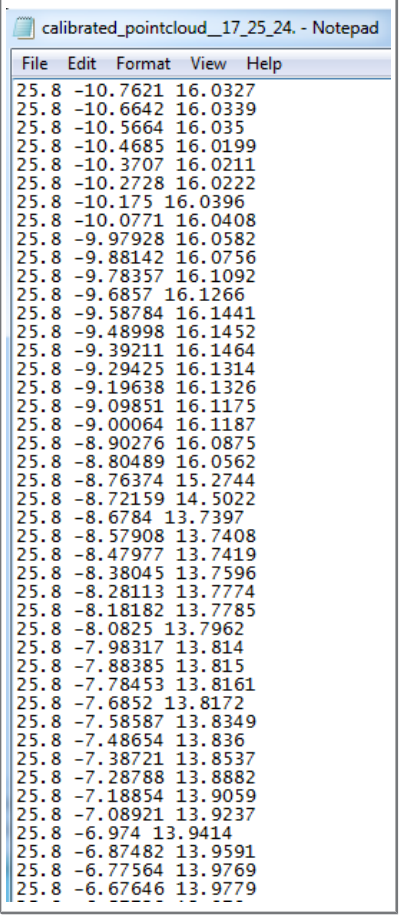
The sensor offers the following calibrated 3D-image formats (in world coordinates X_{World}, Y_{World}, Z_{World} with points in mm):

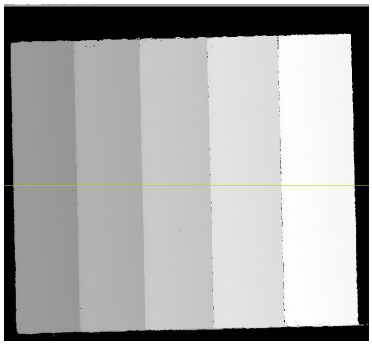
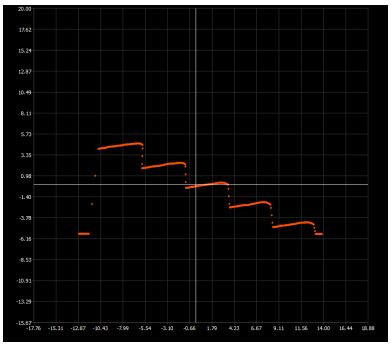
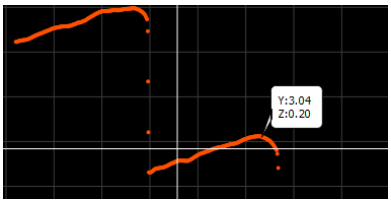
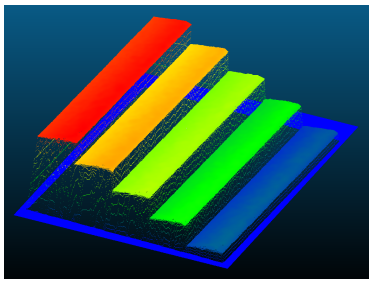
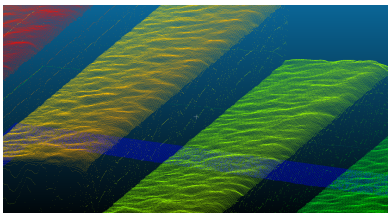
- Point Cloud
- Z-Map
- $Intensity_{Z\text{-}Map}$
- Laser Line $Thickness_{Z\text{-}Map}$

These image formats are abbreviated as ZIL (**Z**-Map, **I**ntensity, **L**aserLineThickness)

Point Cloud

Designation	Description
General	The Point Cloud is a calibrated 3D point cloud, which represents for each point the calibrated point cloud coordinates (X_{World}, Y_{World}, Z_{World}) of the scanned object. 

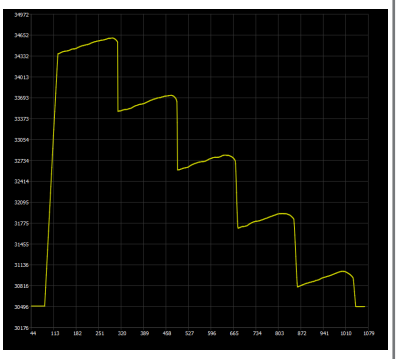
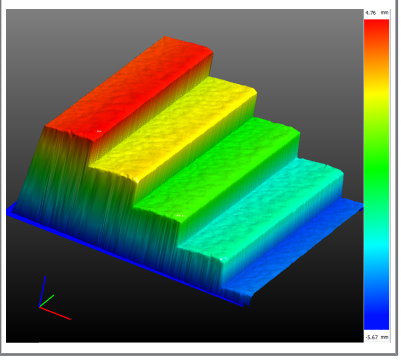
Designation	Description	
Format	The calibrated point cloud co-ordinates (X_{World}, Y_{World}, Z_{World}) are available in the following formats: • ASCII • CSV **NOTE** ASCII-separator: X Y Z ('whitespace' separated), CSV-separator: X,Y,Z ('comma' separated) or X;Y;Z ('semi-colon' separated).	

Designation	Description	
Point Cloud example	**3D Profile Map** 	**Point Cloud of a 3D Profile**  
	3D Visualization of a Point Cloud 	**3D Visualization of a Point Cloud – close-up** 

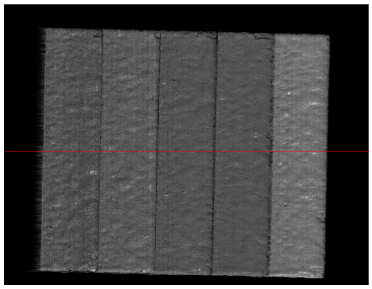
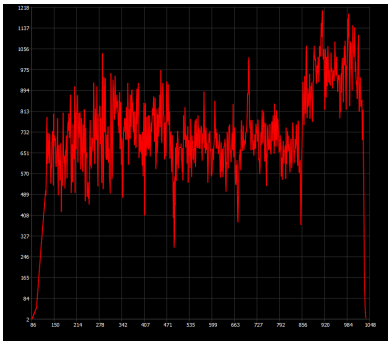
Z-Map

Designation	Description
General	The Z-map is an image, which represents for each pixel the calibrated height (Z-dimension) of the scanned object in world coordinate system. **NOTE** The SmartRay API converts calibrated Point Cloud to a Z-map. For more information on decoding your Z-map pixels back to real world units, i.e. in millimeters, please refer to the illustration in the SmartRay API user manual, under the Chapter "Calibrated Data Control".
Data format	16 bit image (Ex: PNG format) **NOTE** A pixel with a value 32,768 (2^{15}) reflects a height value of 0 mm.

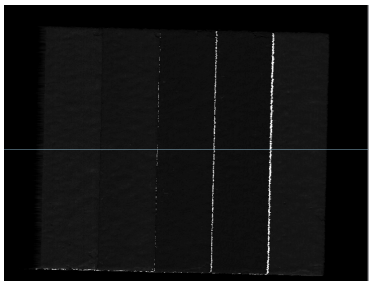
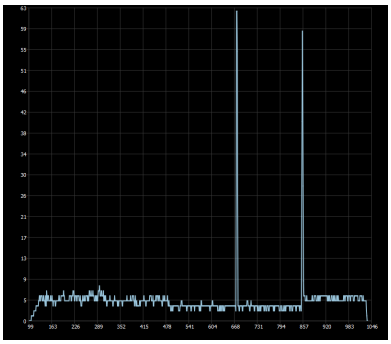
<table>
<tr><th>Designation</th><th colspan="2">Description</th></tr>
<tr><td rowspan="2">Z-Map example

Bit depth: 16 bits/pixel
(range 0 – 65,535)</td><td>Z-Map
 </td><td>Graphical analysis
  </td></tr>
<tr><td>Z-Map
 </td><td>3D Visualization
  </td></tr>
</table>

Intensity$_{Z\text{-}Map}$

Designation	Description	
General	The Intensity$_{Z\text{-}Map}$ image is an image, in which each pixel represents the intensity of the reflected light from the scanned object, additionally realigned to the Z-map.	
Data formt	16 bit image	
Intensity$_{Z\text{-}Map}$ example Bit depth: 16 bits/pixel (range 0 – 65,535)	**Intensity$_{Z\text{-}Map}$** 	**Graphical analysis** 

Laser Line Thickness$_{Z\text{-}Map}$

Designation	Description	
General	The Laser Line Thickness$_{Z\text{-}Map}$ image is an image, in which each pixel represents the thickness of the laser line, additionally realigned to the Z-map.	
Data format	16 bit image	
Lase Line Thickness$_{Z\text{-}Map}$ example Bit depth: 16 bits/pixel (range 0 – 65,535)	**LaserLineThickness$_{Z\text{-}Map}$** 	**Graphical analysis** 

5.4 Troubleshooting

What to do in the event of faults?

If the sensor is not working correctly, please contact Support at SmartRay GmbH.

For the postal address, see *Customer service/Support, page 47*.

Q: What do I do if I am not able to establish a connection to the sensor from my computer?

A: Make sure that :

- the sensor is powered-on,
- the Power LED is glowing blue and the Boot / Connection LED is blinking orange,
- there are no loose contacts on your Power-I/O or Ethernet connectors, or on the network switch, if used,
- the network card of your host computer is configured to lie within the same IP Address range as that of the sensor,
- not more than one software application is trying to connect to the sensor,
- the ARP cache is flushed (Example: by executing "**arp –d ***" using the *windows run command*).

Recommended practices

WARNING

Danger of injury from laser beams.

Looking directly into the beam for a time period of more than 0.25 s or repeatedly looking into the laser beam of class 2M laser products can lead to eye injuries.

- If laser radiation of class 2M hits the eyes, consciously close your eyes and immediately turn away.

- Switch off the laser when not in use.
- Make sure that you do **not** mount the sensor in such a way that a direct or indirect laser reflection could harm you, or your co-workers.
- Always ensure that the sensor is transported based on ESD regulations.

6 Maintenance and repair

6.1 Maintenance

Cleaning deposits

Deposits (dirt, dust etc.) on the front glass of the sensor and the glass region from where the laser is omitted can affect the quality of the measurements. Therefore, regular cleaning is recommended.

NOTICE

Only clean the front glass of the sensor and the glass region from where the laser is omitted with a microfiber cloth and cleaning alcohol if necessary.

WARNING

Mortal danger from electric shock!

To avoid harm to personnel, comply with the following instruction:

- Before maintenance work, disconnect the sensor from the power supply.

6.2 Repair work

Defective sensor or defective sensor cable

WARNING

Danger of injury from escaping laser radiation.

Unauthorized constructional modifications to the sensor can have an adverse effect on safety. SmartRay is solely responsible for repairs. Opening the housing will lead to loss of the guarantee.

- Never disassemble the sensors from SmartRay GmbH.
- Never open a SmartRay sensor.

In the event of a defect of the sensor or sensor cable, send in the defective product for replacement or repair.

ATTENTION

Risk of destroying the sensor.

Because the sensor is a sensitive electronic part, it can be destroyed by improper handling.

- Keep the original packaging and use it in case sending the sensor back for repair will be necessary (ESD protection).

Dismantling the sensor or cables

Dismantle the sensor or defective cables in accordance with section *Dismantling, page 45*.

7 Decommissioning

7.1 Dismantling

General

Final decommissioning and disposal includes the complete de-installation of the sensor.

Dismantling the sensor/cables

WARNING

Mortal danger from electric shock!

To avoid harm to personnel, comply with the following instructions:

- De-installation of the electrical equipment may only be carried out by trained specialist electricians!
- Engage a qualified specialist company for the final disposal!

WARNING

Danger of injury from incorrect handling.

To avoid harm to personnel, comply with the following instructions:

- Observe the relevant safety regulations.
- Observe the applicable accident prevention regulations.

Proceed as follows to disassemble the sensor or defective cables:

Step	Action
1	Disconnect the sensor from the power supply.
2	Disconnect the connected cables from the sensor connectors.
3	Remove the strain relief device and dismantle the sensor from the holder (robot etc.).
4	Unplug the cables.
5	Package and send the sensor and/or cables to SmartRay.

7.2 Storage

Storing sensor components

Proceed as follows to store the sensor components:

Step	Action
1	If possible, store the sensor components in the original packaging in a dry location. If the original packaging is no longer available, store the sensor covered (dust protected) in a dry location.

Ambient conditions

Observe the following ambient conditions during storage:

Admissible storage temperature	-20 to +70 °C
Relative atmospheric humidity	40 to 70%, non-condensing

7.3 Disposal

Procedure

Proceed as follows to the dispose of the sensor and cables:

Step	Action
1	Dispose of the sensor and cables in an environmentally friendly manner in accordance with local provisions as well as the regulations and laws applicable at the time of disposal.
2	Alternatively, send the sensor and cables to: SmartRay GmbH Bürgermeister-Finsterwalder-Ring 12 82515 Wolfratshausen Germany

8 Customer service/Support

8.1 Customer service and support address

Return Material Authorization form

For repairs related and maintenance related requests send the sensor to the following address after filling out the RMA form.

Support address

SmartRay GmbH

Bürgermeister-Finsterwalder-Ring 12

82515 Wolfratshausen

Germany

Tel.:+49 8171 9683 400

Fax: +49 8171 9683 401

E-mail: info@smartray.de

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